CLAIMS

We claim:

1. A method for forming a thermal barrier coating system, the method comprising:

presenting at least one substrate;

depositing at least one of Ti, Ti alloy, or any combination thereof to form a bond coat on at least a portion of at least one said substrate; and

depositing at least one of zirconia, zirconia alloy, TiN, TiC, TiN alloy, TiC alloy,or any combination thereof to form a deposition of a thermal-insulating layer on said bond coat.

2. The method of claim 1, wherein said deposition of said bond coat and thermal insulating layer is accomplished with a deposition method comprising:

at least one of directed vapor deposition (DVD), chemical vapor deposition (CVD), evaporation (thermal, RF, laser, or electron beam), reactive evaporation, sputtering (DC, RF, microwave and/or magnetron), arc plasma deposition, reactive sputtering, electron beam physical vapor deposition (EF-PVD), electroplating, ion plasma deposition (IPD), low pressure plasma spray (LPPS), plasma spray (e.g., air plasma spray (APS)), high velocity oxy-fuel (HVOF), vapor deposition, or cluster deposition.

3. The method of claim 1, wherein said deposition of said bond coat and thermal insulating layer is accomplished with a Directed Vapor Deposition (DVD).

4. The method of claim 3, wherein said DVD technique comprises:

said presenting of at least one of said substrate includes presenting said substrate to a chamber, wherein said chamber has an operating pressure ranging from about 0.1 to about 32,350 Pa,;

presenting at least one additional evaporant sources to said chamber if desired;

presenting at least one carrier gas stream to said chamber;

impinging said desired evaporant source with at least one energetic beam in said chamber to generate an evaporated vapor flux impinged by said electron beam; and

deflecting at least one of said generated evaporated vapor flux by at least one of said carrier gas stream, wherein said evaporated vapor flux:

at least partially coats at least one said substrate to form said bond coat, and

at least partially coats said bond coat to form said thermal-insulating layer coat.

5. The method of claim 4, wherein said energetic beam comprises at least one of electron beam source, laser source, heat source, ion bombardment source, highly focused incoherent light source, microwave, radio frequency, EMF, or any energetic beam that break chemical bonds, or any combination thereof.

6. The method of claim 4, further comprising:

said chamber further includes a substrate bias system capable of applying a DC or alternating potential to at least one of said substrates;

impinging said at least one of said generated vapor flux and at least one of said carrier gas stream with a working gas generated by at least one hollow cathode arc plasma activation source to ionize said at least one of said generated vapor flux and at least one of said carrier gas stream; and

attracting said ionized generated vapor flux and said carrier gas stream to a substrate surface by allowing a self-bias of said ionized gas and vapor stream or said potential to pull the ionized stream to said substrate.

7. The method of claim 6, said generated electrons from said hollow cathode source is regulated for direction through variations in the quantity of working gas passing through said hollow cathode source.

8. The process of claim 6, wherein the distance between said cathode source and said generated evaporated vapor flux is regulated for ionization of the entire generated evaporated vapor flux.

9. The method of claim 4, further comprising at least one nozzle, wherein said at least one carrier gas stream is generated from said at least one nozzle and said at least one evaporant source is disposed in said at least one nozzle.

10. The method claim 9, wherein said evaporant retainer is a crucible.

11. The method of claim 4, further comprising:

said chamber further includes a substrate bias system capable of applying a DC or alternating potential to at least one of said substrates;

impinging said at least one of said generated vapor flux and at least one of said carrier gas stream with a low energy beam to ionize said at least one of said generated vapor flux and at least one of said carrier gas stream; and

attracting said ionized generated vapor flux and said carrier gas stream to a substrate surface by allowing a self-bias of said ionized gas and vapor stream or said potential to pull the ionized stream to said substrate.

12. A method for forming a thermal barrier coating system, the method comprising:

presenting at least one substrate;

depositing at least one of Zr, Zr Alloy, or combination thereof to form a bond coat on at least a portion of at least one said substrate; and

depositing at least one of ZrC or ZrC alloys, or any combination thereof to form a deposition of a thermal-insulating layer on said bond coat.

13. The method of claim 12, wherein said deposition of said bond coat and thermal insulating layer is accomplished with a deposition method comprising:

at least one of directed vapor deposition (DVD), chemical vapor deposition (CVD), evaporation (thermal, RF, laser, or electron beam), reactive evaporation, sputtering (DC, RF, microwave and/or magnetron), arc plasma deposition, reactive sputtering, electron beam physical vapor deposition (EF-PVD), electroplating, ion plasma

deposition (IPD), low pressure plasma spray (LPPS), plasma spray (e.g., air plasma spray (APS)), high velocity oxy-fuel (HVOF), vapor deposition, or cluster deposition.

14. The method of claim 12, wherein said deposition of said bond coat and thermal insulating layer is accomplished with a directed vapor deposition (DVD).

15. A method for forming a thermal barrier coating system, the method comprising:

presenting at least one substrate;

depositing at least one of Nb, Nb alloy, Ta, Ta alloy or any combination thereof to form a bond coat on at least a portion of at least one said substrate; and

depositing at least one of as oxide or a carbide or any combination thereof to form a thermal-insulating layer on said bond coat.

16. The method of claim 15, wherein said deposition of said bond coat and thermal insulating layer is accomplished with a deposition method comprising:

at least one of directed vapor deposition (DVD), chemical vapor deposition (CVD), evaporation (thermal, RF, laser, or electron beam), reactive evaporation, sputtering (DC, RF, microwave and/or magnetron), arc plasma deposition, reactive sputtering, electron beam physical vapor deposition (EF-PVD), electroplating, ion plasma deposition (IPD), low pressure plasma spray (LPPS), plasma spray (e.g., air plasma spray (APS)), high velocity oxy-fuel (HVOF), vapor deposition, or cluster deposition.

17. The method of claim 15, wherein said deposition of said bond coat and thermal insulating layer is accomplished with a Directed Vapor Deposition (DVD).

18. The method of claim 15, wherein said thermal insulating layer comprises at least one of TaC or TaC alloys, or any combination thereof.

19. The method of claim 15, further comprising an intermediate layer between said bond coat and said thermal insulating layer.

20. The method of claim 19, wherein said intermediate layer comprises at least one of Ti or Ti alloy.

21. A method for forming a thermal barrier coating system, the method comprising:

presenting at least one substrate;

depositing at least one of stainless steel, composite of stainless steel, or alloy of stainless steel, or any combination thereof to form a bond coat on at least a portion of at least one said substrate; and

depositing a thermal-insulating layer on said bond coat.

22. The method of claim 21, wherein said deposition of said bond coat and thermal insulating layer is accomplished with a deposition method comprising:

at least one of directed vapor deposition (DVD), chemical vapor deposition (CVD), evaporation (thermal, RF, laser, or electron beam), reactive evaporation, sputtering (DC, RF, microwave and/or magnetron), arc plasma deposition, reactive sputtering, electron beam physical vapor deposition (EF-PVD), electroplating, ion plasma deposition (IPD), low pressure plasma spray (LPPS), plasma spray (e.g., air plasma spray (APS)), high velocity oxy-fuel (HVOF), vapor deposition, or cluster deposition.

23. The method of claim 21, wherein said deposition of said bond coat and thermal insulating layer is accomplished with a Directed Vapor Deposition (DVD).

24. The method of claim 21, wherein said thermal insulating layer comprises TiN, TiC, TiN alloy, TiC alloy, ZrC, ZrC alloys, Cu, Cu alloys, or any combination thereof.

25. A method for forming a thermal barrier coating system, the method comprising:

presenting at least one substrate;

depositing at least one intermetallic to form a bond coat on at least a portion of at least one said; and

depositing a thermal-insulating layer on said bond coat.

26. The method of claim 25, wherein said deposition of said bond coat and thermal insulating layer is accomplished with a deposition method comprising:

at least one of directed vapor deposition (DVD), chemical vapor deposition (CVD), evaporation (thermal, RF, laser, or electron beam), reactive evaporation, sputtering (DC, RF, microwave and/or magnetron), arc plasma deposition, reactive sputtering, electron beam physical vapor deposition (EF-PVD), electroplating, ion plasma deposition (IPD), low pressure plasma spray (LPPS), plasma spray (e.g., air plasma spray (APS)), high velocity oxy-fuel (HVOF), vapor deposition, or cluster deposition.

27. The method of claim 25, wherein said deposition of said bond coat and thermal insulating layer is accomplished with a Directed Vapor Deposition (DVD).

28. The method of claim 25, wherein said thermal insulating layer comprises TiN, TiC, TiN alloy, TiC alloy, ZrC, ZrC alloys, Cu, Cu alloys, or any combination thereof.

29. The method of claim 25, wherein said intermetallic material comprise at least one of intermetallic compound, or any combination of intermetallic compounds.

30. A deposition apparatus for forming a thermal barrier coating system, the apparatus comprising:

a housing, wherein at least one substrate is presented in said housing;

a deposition means for depositing at least one of Ti, Ti alloy, or any combination

thereof to form a bond coat on at least a portion of at least one said substrate; and

said deposition means for depositing at least one of zirconia, zirconia alloy, TiN, TiC, TiN alloy, TiC or any combination thereof to form a deposition of a thermal-insulating layer on said bond coat.

31. The apparatus of claim 30, wherein said deposition means comprises:

at least one of directed vapor deposition (DVD) apparatus, chemical vapor deposition (CVD) apparatus, evaporation (thermal, RF, laser, or electron beam) apparatus, reactive evaporation apparatus, sputtering (DC, RF, microwave and/or magnetron) apparatus, arc plasma deposition apparatus, reactive sputtering apparatus, electron beam physical vapor deposition (EF-PVD) apparatus, electroplating apparatus, ion plasma deposition (IPD) apparatus, low pressure plasma spray (LPPS) apparatus, plasma spray (e.g., air plasma spray (APS)) apparatus, high velocity oxy-fuel (HVOF) apparatus, vapor deposition apparatus, or cluster deposition apparatus.

32. The apparatus of claim 30, wherein said deposition means comprises:

a directed vapor deposition (DVD) apparatus.

33. A directed vapor deposition (DVD) apparatus for forming a thermal barrier coating system, the apparatus comprising:

a chamber, wherein said chamber has an operating pressure ranging from about 0.1 to about 32,350 Pa, wherein at least one substrate is presented in said chamber;

at least one evaporant source disposed in said chamber;

at least one carrier gas stream provided in said chamber; and

an energetic beam system providing at least one energetic beam,

said energetic beam:

impinging at least one said evaporant source with at least one said energetic beam in said chamber to generate a bond coat evaporated vapor flux, said at least one evaporant source comprising at least one of Ti, Ti alloy, or any combination thereof to form, and

deflecting at least one of said generated bond coat evaporated vapor flux by at least one of said carrier gas stream, wherein said bond coat evaporated vapor flux at least partially coats at least one of said substrates to form said bond coat; and

said energetic beam:

impinging at least one of said evaporant source with at least one said energetic beam in said chamber to generate a thermal-insulating layer evaporated vapor flux, wherein said evaporant source for generating said thermal-insulating layer comprise at least one of zirconia, zirconia alloy, TiN, TiC, TiN alloy, TiC or combination thereof, and

deflecting at least one of said thermal-insulating layer generated evaporated vapor flux by at least one of said carrier gas stream, wherein said thermal-insulating layer evaporated vapor flux at least partially coats at least one of said substrates to form said thermal-insulating layer on said bond coat.

34. The method of claim 33, wherein said energetic beam comprises at least one of electron beam source, electron gun source, laser source, heat source, ion bombardment source, highly focused incoherent light source, microwave, radio frequency, EMF, or any energetic beam system that breaks chemical bonds, or combination thereof.

35. The apparatus of claim 33, further comprising:

a substrate bias system capable of applying a DC or alternating potential to at least one of said substrates;

at least one hollow cathode arc source generating a low voltage beam, said at least one hollow cathode arc source:

impinging said at least one of said generated vapor flux and at least one of said carrier gas stream with a working gas generated by at least one said hollow

cathode arc plasma activation source to ionize said at least one of said generated vapor flux and at least one of said carrier gas stream; and

attracting said ionized generated vapor flux and said carrier gas stream to a substrate surface by allowing a self-bias of said ionized gas and vapor stream or said potential to pull the ionized stream to said substrate.

36. The apparatus of claim 35, wherein said hollow cathode arc source comprises at least one cathode orifice wherein a predetermined selection of said cathode orifices are arranged in close proximity to the gas and vapor stream; and

an anode is arranged opposite of said cathode source wherein the gas and vapor stream is there between said cathode source and said anode.

37. The apparatus of claim 33, further comprising at least one nozzle, wherein said at least one carrier gas stream is generated from said at least one nozzle and said at least one evaporant source is disposed in said at least one nozzle, wherein said at least one said nozzle comprises:

at least one nozzle gap wherein said at least one said carrier gas flows there from; and

at least one evaporant retainer for retaining at least one said evaporant source, said evaporant retainer being at least substantially surrounded by at least one said nozzle gap.

38. The apparatus of claim 37, wherein said evaporant retainer is a crucible.

39. The apparatus of claim 33, further comprising:

a substrate bias system capable of applying a DC or alternating potential to at least one of said substrates;

at least one low energy beam source for generating a low voltage beam, said at least one low energy beam source:

impinging said at least one of said generated vapor flux and at least one of said carrier gas stream with a low energy beam to ionize said at least one of said generated vapor flux and at least one of said carrier gas stream; and

attracting said ionized generated vapor flux and said carrier gas stream to a substrate surface by allowing a self-bias of said ionized gas and vapor stream or said potential to pull the ionized stream to said substrate.

40. A deposition apparatus for forming a thermal barrier coating system, the apparatus comprising:

a housing, wherein at least one substrate is presented in said housing;

a deposition means, said deposition means for depositing at least one of Zr, Zr alloy, or combination thereof to form a bond coat on at least a portion of at least one said substrate; and

said deposition means for depositing at least one of ZrC, ZrC alloy, or any combination thereof to form a deposition of a thermal-insulating layer on said bond coat.

41. The apparatus of claim 40, wherein said deposition means comprises:

at least one of directed vapor deposition (DVD) apparatus, chemical vapor deposition (CVD) apparatus, evaporation (thermal, RF, laser, or electron beam) apparatus, reactive evaporation apparatus, sputtering (DC, RF, microwave and/or magnetron) apparatus, arc plasma deposition apparatus, reactive sputtering apparatus, electron beam physical vapor deposition (EF-PVD) apparatus, electroplating apparatus, ion plasma deposition (IPD) apparatus, low pressure plasma spray (LPPS) apparatus, plasma spray (e.g., air plasma spray (APS)) apparatus, high velocity oxy-fuel (HVOF) apparatus, vapor deposition apparatus, or cluster deposition apparatus.

42. The apparatus of claim 41, wherein said deposition means comprises:

a directed vapor deposition (DVD) apparatus.

43. A directed vapor deposition (DVD) apparatus for forming a thermal barrier

coating system, the apparatus comprising:

a chamber, wherein said chamber has an operating pressure ranging from about 0.1 to about 32,350 Pa, wherein at least one substrate is presented in said chamber;

at least one evaporant source disposed in said chamber;

at least one carrier gas stream provided in said chamber; and

an energetic beam system providing at least one energetic beam,

said energetic beam:

impinging at least one said evaporant source with at least one said energetic beam in said chamber to generate a bond coat evaporated vapor flux, said at least one evaporant source comprising at least one of Zr, Zr alloy, or any combination thereof, and

deflecting at least one of said generated bond coat evaporated vapor flux by at least one of said carrier gas stream, wherein said bond coat evaporated vapor flux at least partially coats at least one of said substrates to form said bond coat; and

said energetic beam:,

impinging at least one of said evaporant source with at least one said energetic beam in said chamber to generate a thermal-insulating layer evaporated vapor flux, wherein said evaporant source for generating said thermal-insulating layer comprise at least one of ZrC, ZrC alloys, or any combination thereof or any of their alloys, and

deflecting at least one of said thermal-insulating layer generated evaporated vapor flux by at least one of said carrier gas stream, wherein said thermal-insulating layer evaporated vapor flux at least partially coats at least one of said substrates to form said thermal-insulating layer on said bond coat.

44. A deposition apparatus for forming a thermal barrier coating system, the apparatus comprising:

a depositing means, said depositing means for depositing a at least one of Nb, Nb

alloy, Ta, Ta alloy or any combination thereof to form bond coat on at least a portion of at least one said substrate; and

said depositing means for depositing at least one of an oxide or a carbide to form a thermal-insulating layer.

45. The apparatus of claim 44, wherein said deposition means comprises:

at least one of directed vapor deposition (DVD) apparatus, chemical vapor deposition (CVD) apparatus, evaporation (thermal, RF, laser, or electron beam) apparatus, reactive evaporation apparatus, sputtering (DC, RF, microwave and/or magnetron) apparatus, arc plasma deposition apparatus, reactive sputtering apparatus, electron beam physical vapor deposition (EF-PVD) apparatus, electroplating apparatus, ion plasma deposition (IPD) apparatus, low pressure plasma spray (LPPS) apparatus, plasma spray (e.g., air plasma spray (APS)) apparatus, high velocity oxy-fuel (HVOF) apparatus, vapor deposition apparatus, or cluster deposition apparatus.

46. The apparatus of claim 44, wherein said deposition means comprises:

a directed vapor deposition (DVD) apparatus.

47. The apparatus of claim 44, wherein said thermal insulating layer comprises at least one of TaC or TaC alloys, or any combination thereof.

48. The apparatus of claim 44, said depositing means for depositing an intermediate layer between said bond coat and said thermal insulating layer.

49. The method of claim 48, wherein said intermediate layer comprises at least one of Ti or Ti alloy.

50. A directed vapor deposition (DVD) apparatus for forming a thermal barrier coating system, the apparatus comprising:

a chamber, wherein said chamber has an operating pressure ranging from about 0.1 to about 32,350 Pa, wherein at least one substrate is presented in said chamber;

at least one evaporant source disposed in said chamber;

at least one carrier gas stream provided in said chamber; and

an energetic beam system providing at least one energetic beam,

said energetic beam:

impinging at least one said evaporant source with at least one said energetic beam in said chamber to generate a bond coat evaporated vapor flux, said at least one evaporant source comprising at least one of Nb, Nb alloy, Ta, Ta alloy or any combination thereof, and

deflecting at least one of said generated bond coat evaporated vapor flux by at least one of said carrier gas stream, wherein said bond coat evaporated vapor flux at least partially coats at least one of said substrates to form said bond coat; and

said energetic beam:

impinging at least one of said evaporant source with at least one said energetic beam in said chamber to generate a thermal-insulating layer evaporated vapor flux, wherein said evaporant source for generating said thermal-insulating layer comprises at least one of an oxide or carbide, and

deflecting at least one of said thermal-insulating layer generated evaporated vapor flux by at least one of said carrier gas stream, wherein said thermal-insulating layer evaporated vapor flux at least partially coats at least one of said substrates to form said thermal-insulating layer on said bond coat.

51. A deposition apparatus for forming a thermal barrier coating system, the apparatus comprising:

a depositing means, said depositing means for depositing at least one of stainless steel, composite of stainless steel, or alloy of stainless steel, or any combination thereof to form a bond coat on at least a portion of at least one said substrate; and

said depositing means for depositing a thermal-insulating layer.

52. The apparatus of claim 51, wherein said deposition means comprises:

at least one of directed vapor deposition (DVD) apparatus, chemical vapor deposition (CVD) apparatus, evaporation (thermal, RF, laser, or electron beam) apparatus, reactive evaporation apparatus, sputtering (DC, RF, microwave and/or magnetron) apparatus, arc plasma deposition apparatus, reactive sputtering apparatus, electron beam physical vapor deposition (EF-PVD) apparatus, electroplating apparatus, ion plasma deposition (IPD) apparatus, low pressure plasma spray (LPPS) apparatus, plasma spray (e.g., air plasma spray (APS)) apparatus, high velocity oxy-fuel (HVOF) apparatus, vapor deposition apparatus, or cluster deposition apparatus.

53. The apparatus of claim 51, wherein said deposition means comprises:

a directed vapor deposition (DVD) apparatus.

54. The apparatus of claim 51, wherein said thermal insulating layer comprises TiN, TiC, TiN alloy, TiC alloy, ZrC, ZrC alloys, Cu, Cu alloys, or any combination thereof.

55. A directed vapor deposition (DVD) apparatus for forming a thermal barrier coating system, the apparatus comprising:

a chamber, wherein said chamber has an operating pressure ranging from about 0.1 to about 32,350 Pa, wherein at least one substrate is presented in said chamber;

at least one evaporant source disposed in said chamber;

at least one carrier gas stream provided in said chamber; and

an energetic beam system providing at least one energetic beam,

said energetic beam:

impinging at least one said evaporant source with at least one said energetic beam in said chamber to generate a bond coat evaporated vapor flux, wherein said evaporant source comprises at least one of stainless

steel, composite of stainless steel, or alloy of stainless steel, or any combination thereof, and

deflecting at least one of said generated bond coat evaporated vapor flux by at least one of said carrier gas stream, wherein said bond coat evaporated vapor flux at least partially coats at least one of said substrates to form said bond coat; and

said energetic beam:

impinging at least one of said evaporant source with at least one said energetic beam in said chamber to generate a thermal-insulating layer evaporated vapor flux, and

deflecting at least one of said thermal-insulating layer generated evaporated vapor flux by at least one of said carrier gas stream, wherein said thermal-insulating layer evaporated vapor flux at least partially coats at least one of said substrates to form said thermal-insulating layer on said bond coat.

56. A deposition apparatus for forming a thermal barrier coating system, the apparatus comprising:

a depositing means, said depositing means for depositing at least one of intermetallic; and

said depositing means for depositing a thermal-insulating layer.

57. The apparatus of claim 56, wherein said deposition means comprises:

at least one of directed vapor deposition (DVD) apparatus, chemical vapor deposition (CVD) apparatus, evaporation (thermal, RF, laser, or electron beam) apparatus, reactive evaporation apparatus, sputtering (DC, RF, microwave and/or magnetron) apparatus, arc plasma deposition apparatus, reactive sputtering apparatus, electron beam physical vapor deposition (EF-PVD) apparatus, electroplating apparatus, ion plasma deposition (IPD) apparatus, low pressure plasma spray (LPPS) apparatus, plasma spray (e.g., air plasma spray (APS)) apparatus, high velocity oxy-fuel (HVOF)

apparatus, vapor deposition apparatus, or cluster deposition apparatus.

58. The apparatus of claim 56, wherein said deposition means comprises:
a directed vapor deposition (DVD) apparatus.

59. A directed vapor deposition (DVD) apparatus for forming a thermal barrier coating system, the apparatus comprising:

a chamber, wherein said chamber has an operating pressure ranging from about 0.1 to about 32,350 Pa, wherein at least one substrate is presented in said chamber;

at least one evaporant source disposed in said chamber;

at least one carrier gas stream provided in said chamber; and

an energetic beam system providing at least one energetic beam,

said energetic beam:

impinging at least one said evaporant source with at least one said energetic beam in said chamber to generate a bond coat evaporated vapor flux, wherein said evaporant source comprises at least one intermetallic material, and

deflecting at least one of said generated bond coat evaporated vapor flux by at least one of said carrier gas stream, wherein said bond coat evaporated vapor flux at least partially coats at least one of said substrates to form said bond coat; and

said energetic beam:

impinging at least one of said evaporant source with at least one said energetic beam in said chamber to generate a thermal-insulating layer evaporated vapor flux, and

deflecting at least one of said thermal-insulating layer generated evaporated vapor flux by at least one of said carrier gas stream, wherein said thermal-insulating layer evaporated vapor flux at least partially coats at least one of said substrates to form said thermal-insulating layer on said bond coat.

60. A coating system on a substrate, the coating system comprising:

a bond coat in communication with at least a portion of said substrate, said bond coat comprising least one of Ti, Ti alloy, or any combination thereof; and

a thermal-insulating layer in communication with at least a portion of said bond coat, said thermal-insulating layer comprising at least one of zirconia, zirconia alloy, TiN, TiC, TiN alloy, TiC alloy or any combination thereof.

61. A coating system on a substrate, the coating system comprising:

a bond coat in communication with at least a portion of said substrate, said bond coat comprising least one of Zr, Zr Alloy,, or any combination thereof; and

a thermal-insulating layer in communication with at least a portion of said bond coat, said thermal-insulating layer comprising at least one of ZrC, ZrC alloys or any combination thereof.

62. A coating system on a substrate, the coating system comprising:

a bond coat in communication with at least a portion of said substrate, said bond coat comprising least one of Nb, Nb alloy, Ta, Ta alloy, or any combination thereof; and

a thermal-insulating layer comprised of at least one of an oxide or a carbide, or combination thereof, in communication with at least a portion of said bond coat.

63. The system of claim 62, wherein said thermal insulating layer comprises at least one of TaC or TaC alloys, or any combination thereof.

64. The system of claim 62, further comprising an intermediate layer disposed between said bond coat and said thermal insulating layer.

65. The system of claim 64, wherein said intermediate layer comprises at least one of Ti or Ti alloy.

66. A coating system on a substrate, the coating system comprising:

a bond coat in communication with at least a portion of said substrate, said bond coat comprising least one of at least one of stainless steel, composite of stainless steel, or alloy of stainless steel, or any combination thereof; and

a thermal-insulating layer in communication with at least a portion of said bond coat.

67. The system of claim 66, wherein said thermal insulating layer comprises TiN, TiC, TiN alloy, TiC alloy, ZrC, ZrC alloys, Cu, Cu alloys, or any combination thereof.

68. A coating system on a substrate, the coating system comprising:

a bond coat in communication with at least a portion of said substrate, said bond coat comprising intermetallic material; and

a thermal-insulating layer in communication with at least a portion of said bond coat.

69. The method of claim 68, wherein said thermal insulating layer comprises TiN, TiC, TiN alloy, TiC alloy, ZrC, ZrC alloys, Cu, Cu alloys, or any combination thereof.

70. The method of claim 68, wherein said intermetallic material comprise at least one of intermetallic compound, or any combination of intermetallic compounds.

71. The system of any one of claims 60, 61, 62, 66, or 68, wherein said substrate is at least one of:

rocket engine component, space reentry vehicle component, scram jet component, hypersonic vehicle component, fusion reactor component, gas turbine engine component, diesel engine component, turbine blade, or airfoil.

72. The system of any one of claims 60, 61, 62, 66, or 68, wherein said deposition technique of said bond coat and thermal insulating layer is accomplished with a deposition method comprising:

at least one of directed vapor deposition (DVD), chemical vapor deposition (CVD), evaporation (thermal, RF, laser, or electron beam), reactive evaporation, sputtering (DC, RF, microwave and/or magnetron), arc plasma deposition, reactive sputtering, electron beam physical vapor deposition (EF-PVD), electroplating, ion plasma deposition (IPD), low pressure plasma spray (LPPS), plasma spray (e.g., air plasma spray (APS)), high velocity oxy-fuel (HVOF), vapor deposition, or cluster deposition.

73. The system of any one of claims 60, 61, 62, 66, or 68, wherein said deposition technique of said bond coat and thermal insulating layer is accomplished with a directed vapor deposition (DVD).